concerning the cultural distinctiveness of the region. While this may be due in part to the lack of corroborating data in other artifact categories, the problem may also lie in the nature of the defined units of study. What does the distribution of architectural and ceramic styles or types represent in terms of social and economic unit boundaries?

The article by Robert Wauchope on Protohistoric pottery from the Guatemalan highlands contains some sobering evidence concerning this question. In describing pottery collections from a limited time span, Wauchope also examines how his ceramic types correlate with known Protohistoric and early historic political, economic, and linguistic boundaries. Although Wauchope finds a tendency for localized popularity of certain types, and especially certain shape and decorative attributes which cut across types, the broad distribution of types does not appear to correlate significantly with those boundaries. This casts doubt on the meaningfulness of stylistically defined cultural boundaries, especially within ecologically and culturally homogeneous regions.

Despite the problems in using typologies based on stylistic attributes, such systems are still popular. Certainly for tracing broadly defined "influences" over large regions, for tracing origins of cultural groupings, and for chronological placement taxonomic schemes are most useful. Articles by Gordon R. Willey and Jeremy A. Sabloff on Seibal ceramics and William R. Bullard on excavations at the Postclassic site of Topoxte effectively use the taxonomic type-variety system for those purposes. Descriptions are formal and detailed, with cross-cutting attributes listed for each type. Types are fully described, diagnostic attributes stressed, intra- and intersite contexts discussed. Illustrations are profuse and well executed.

In spite of the thoroughness of the analyses and descriptions, however, one still feels a slight unease. The type-variety system is geared to solve only a limited range of problems of culture history. Explanations of variability within and between complexes tend to rely inordinately on temporal placement, to the exclusion of other possible hypotheses. Outside influences are noted, but the specific nature of those influences in terms of significant sociopolitical or economic changes often is not fully explored. Bullard, for example, notes the distinctiveness of the pottery assemblage from Topoxte in comparison with nearby Postclassic sites and explains this distinctiveness as being due to the later chronological placement of Topoxte. Alternative hypotheses are not explicitly formulated and tested. We should keep in mind that the Seibal reports in particular are preliminary reports concentrating on the chronological placement and cultural affiliations of the Seibal materials, however. It is to be hoped that the final reports will examine other aspects of the data, allowing for a more complete description of the structure of ancient Seibal.

As archeologists increasingly use the variability in their data to test hypotheses about ancient cultural systems, explicit statements of research designs which take into account sampling problems become more common. A paper by Gair Tourtellot on survey and excavations in the periphery of Seibal is representative of the genre. The results of the survey provide added data to our small but rapidly expanding body of knowledge on the evolution of Maya communities.

Finally one should note a final section of shorter essays. All are of high quality, especially that by Tatiana Proskouriakoff, who uses sculptural and legendary material to shed new light on the nature of that shadowy group known as the Itza. Works of this sort go far toward dispelling the idea that the demands of anthropological and historical perspectives in archeology are irreconcilable.

ROBERT E. FRY
Anthropology Section,
Department of Sociology,
Purdue University, Lafayette, Indiana

Physics

Lectures on Elementary Particles and Quantum Field Theory. 1970 Brandeis University Summer Institute in Theoretical Physics. STANLEY DESER, MARC GRISARU, and HUGH PENDLETON, Eds. M.I.T. Press, Cambridge, Mass., 1971. Vol. 1, x, 592 pp., illus. Cloth, $17.50; paper, $7.95. Vol. 2, viii, 502 pp., illus. Cloth, $17.50; paper, $6.95.

The two volumes under review are the latest additions to the Brandeis Summer School Lecture Series which for over ten years has served the theoretical physics community well. At this school leading theoreticians either review successful theories that have achieved some measure of acceptance or summarize speculative developments that are currently being researched.

By the summer of 1970, the subject of current algebra seemed exhausted, and Weinberg provides a timely summary. A synthesis is especially useful here, for development had proceeded in three directions which did not always seem related: (i) current algebra is a property of *weak and electromagnetic* currents; (ii) current algebra reflects a symmetry (chirality) of the *strong* interactions; (iii) current algebra provides low energy theorems for the scattering matrix. Much of Weinberg's research in this area concerned itself with connecting these three approaches. His lectures therefore give the subject a logical coherence that it did not possess historically.

One of the strengths of current algebra is its apparent model independence; many different dynamical schemes seem to lead to the same algebraic structure. Thus one can hope to obtain results without making detailed dynamical assumptions. It has become clear recently, however, that in many theories where conventional current algebra appears to hold, the solutions to that theory do not respect the current algebraic constraints. The causes of this "anomalous" behavior are the notorious divergences of relativistic quantum field theory: a model that appears to satisfy current algebra is undefined, and the process of defining it—the renormalization procedure—spoils the current algebra. These anomalies are not new; first Schwinger and then Johnson and Low called attention to them. But it was Adler, among others, who demonstrated that they have important experimental consequences and are not mathematical curiosities. In his lectures Adler summarizes the extensive investigations which showed that those results of current algebra which are unrelated to the symmetry are not maintained in perturbative solutions to model field theories. On the other hand, the current algebraic theorems reflecting the symmetry seem to be preserved, with one important exception, which has to do with the electromagnetic decay of the neutral pion (and other pseudoscalar mesons). For some time it had been thought that this process cannot occur if chiral invariance is approximately true. However, it *does* occur in the perturbative solutions to the σ model—the paradigm of chirally invariant the-

ories. The anomaly is now understood: it is impossible to maintain chirality, and the associated current algebra, in the presence of electrodynamics in any theory that includes Fermion fields. Adler does not tell us, since no one knows at the present time, whether or not anomalies are present in nature as well. The anomaly associated with pion decay seems to be experimentally indicated, since that decay is observed. However, other anomalies do not have clear experimental verification.

Much speculative theory has been built on the recent M.I.T.-SLAC investigation of inelastic electron-nucleon scattering in a certain high energy domain. One way of understanding the data is to say that masses become irrelevant and a new symmetry sets in in this high energy region. The symmetry is called scale or dilatation invariance and corresponds to the possibility of rescaling space-time parameters in a theory without affecting physical content. (This is somewhat analogous to the symmetry of translation invariance —the possibility of translating space-time parameters without affecting physical content.) That this symmetry should be useful for particle physics was first advocated by Kastrup and Wess; and now, motivated by the M.I.T.-SLAC data, many people have looked into the subject. One result has been the clarification of the nature of the energy-momentum tensor in local field theory. Also, it was suggested by Mack and later by Gell-Mann that there may be a simple connection between chirality and scale invariance since both symmetries appear to be broken by masses. All this is discussed in Zumino's lecture, where extensive use is made of effective Lagrangians, a technique introduced into physics by Weinberg and Schwinger. More recent investigations, however, have shown that anomalies, which were the exception in current algebra, are the rule here; and it is still uncertain if and how scale symmetry can be usefully employed in particle physics. Wilson has suggested that scale invariance places important constraints on the short distance behavior of products of local field operators, and Zimmermann's lectures report on the verification of Wilson's ideas in perturbation theory.

A more successful speculation is that of duality in hadron physics: it is postulated that the high-energy Regge model should be valid at low energies, while low energy resonance dominance should extend to high energies. Jacob develops these ideas with strong emphasis on phenomenological applications, and Mandelstam lectures on the abstract dual-resonance model which has arisen largely from the work of Fubini and Veneziano. Though beset by several serious shortcomings, this model exhibits in a remarkably elegant and compact fashion many of the constraints that duality, Regge ideas, and other such concepts impose on physical scattering amplitudes. These two lectures are an excellent discussion of an idea that may finally succeed in providing a useful model for hadron dynamics.

These volumes can be recommended as timely introduction to many subjects of current interest in theoretical particle physics.

ROMAN JACKIW
Department of Physics, Massachusetts Institute of Technology, Cambridge

Nonideal Techniques

Probes of Structure and Function of Macromolecules and Membranes. Proceedings of a Johnson Research Foundation colloquium, Philadelphia, April 1969. Academic Press, New York, 1971. Vol. 1, Probes and Membrane Function. BRITTON CHANCE, CHUAN-PU LEE, and J .KENT BLASIE, Eds. xxx, 552 pp., illus. $13.50. Vol. 2, Probes of Enzymes and Hemoproteins. BRITTON CHANCE, TAKASHI YONETANI, and ALBERT S. MILDVAN, Eds. xxviii, 626 pp., illus. $14.

These two volumes contain 120 articles plus discussions resulting from the fifth Johnson Research Foundation Colloquium. The experiments discussed have the goal of determining the detailed structural basis of enzyme activity and membrane function. Obviously this would not be a great problem if we had an ideal microscope, one applicable to hydrated materials, with 0.1 Å spatial resolution and 10 nsec time resolution. But we do not, and against the ideal microscope must be set the numerous and nonideal techniques available to biologists at present and described in these volumes.

The first and most valuable portion of the colloquium is the sections on techniques. For many techniques, the articles emphasize limitations and difficulties in interpretation not often enough made explicit in the general literature. Several articles discuss fluorescence and absorption methods, and single articles are devoted to nuclear magnetic resonance, electron paramagnetic resonance, nuclear magnetic relaxation, and electron-nuclear double resonance, all of which have only recently been applied to biological problems.

The second section of the colloquium is concerned with the application of the fluorescent probe technique to membrane function. Two-thirds of these articles are about mitochondria and a slightly different two-thirds are contributions from the Johnson Foundation itself.

Three further sections are devoted to the variety of approaches being used to determine structure-function relationships in mitochondria, in dehydrogenases, and in hemoproteins. A small section is devoted to improvements in instrument technology.

The volumes are not intended as an introduction for the novice. The first article of the second volume begins with the sentence, "A 5 Å resolution electron density map of dogfish M4LDH, which crystalizes in space group F422 with a = 146.9 Å, c = 155.1 Å and a single peptide chain (MW 35,000) in the asymmetric unit, has been obtained. . . ." The terms "State 3," "State 4," and "State 5" are frequently used to describe mitochondria but no hint is given about their meaning. No serious editing seems to have been done. While the excitement (and acrimony) of the discussion is thus preserved, the less well informed reader is poorly served.

The volumes were produced by offset reproduction of typewritten pages. In spite of the rapid publication method, the delay between symposium and publication was two years and some months. Only a few of the articles are updated with notes added in proof.

Improvements approaching the ideal microscope may be forthcoming. At the colloquium Parsons described attempts to develop electron microscopy for hydrated samples. Since then, more powerful x-ray sources have been introduced which may add time resolution to the spatial resolution of this technique. Better probes and spin labels are being synthesized. Thus there is real hope that the articles in the two volumes represent only the beginning of a molecular understanding of enzyme and membrane function.

LARRY COHEN
Department of Physiology, Yale University School of Medicine, New Haven, Connecticut